Implications of Biological Trends for Estimation of Biological Reference Points

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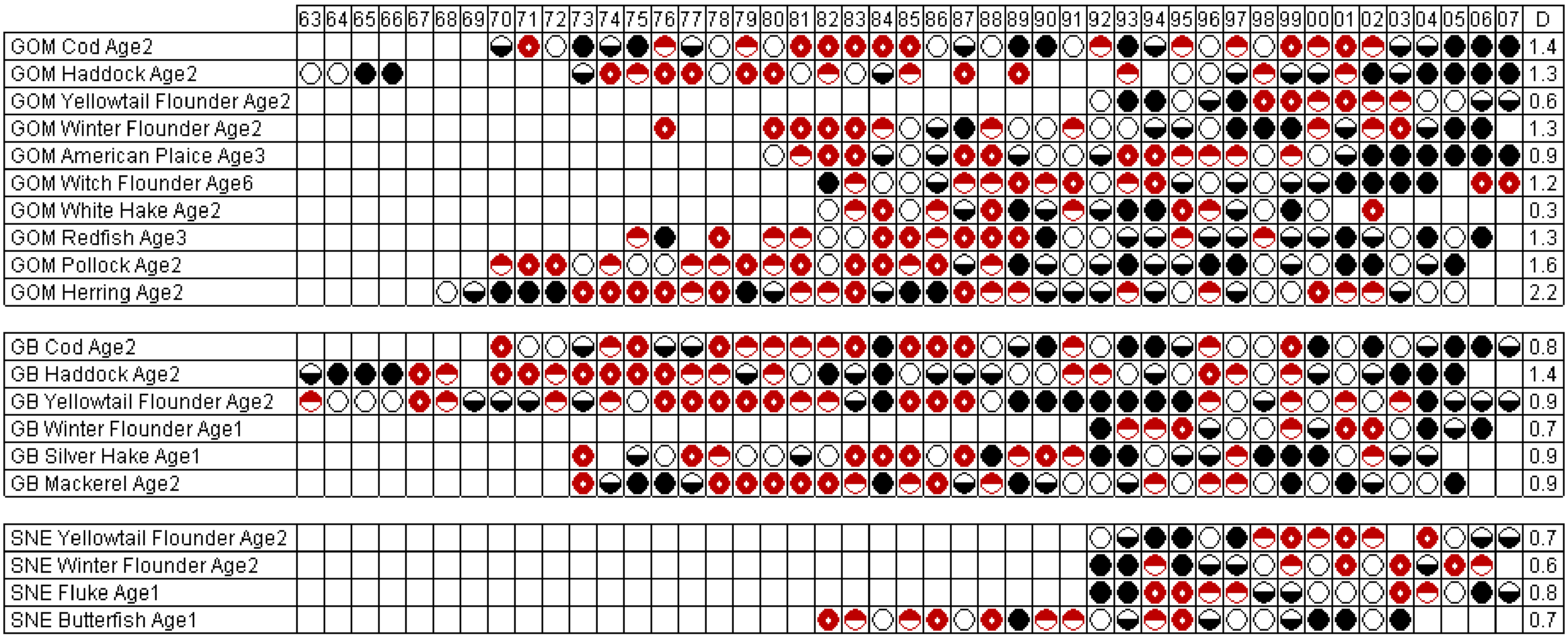
Biological Trends: The basics

- Smaller size at age, delayed maturity at age, and decreased survival of recruits are measures of reduced productivity that induce
  - smaller biomass reference points,
  - lower fishing mortality rates,
  - slower rebuilding rates,
  - lower total landings during rebuilding, and
  - increases in discarding.
- Such consequences are important for fisheries management and support of fisheries. When the trends in biological productivity are unrecognized or masked by other factors assessment models will:
  - overestimate allowable landings,
  - overestimate spawning stock potential, and
  - lead to overly optimistic predictions of stock recovery.
- Failing to correct allowable catches for such changes can further reduce stock sizes and curtail nascent recoveries.

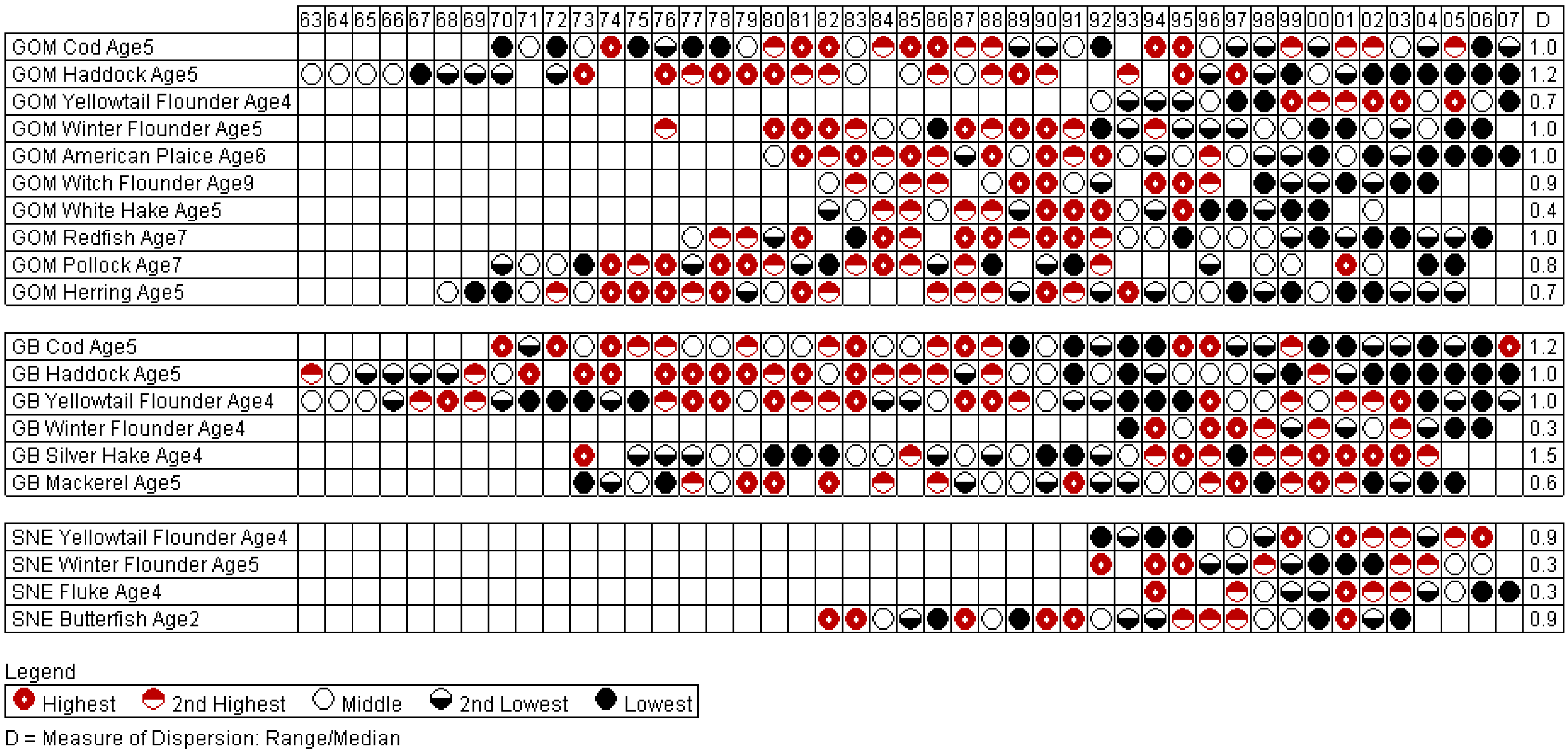
Reduced Average Weight at Age Implies:

- More fish are killed per ton of fish landed or discarded. Therefore quotas need to be reduced to attain the desired mortality rates
- Discarding can increase if technical measures fail to adequately protect undersized fish. Minimum size regulations can become counter productive if large fractions of a slow growing cohort are discarded.
- Even in the absence of discarding, yields from slow growing cohorts would be reduced by natural mortality up to the age when they are legal sized.
- Effectiveness of gear changes, trip limits, and seasonal closures may also be reduced.
- Reduced average size at age may alter the age-specific force of mortality on the population.
- To the extent that age or size-specific selectivity is changing over time, the comparability of measures of fishing mortality is compromised.
  - Strictly speaking, measures of Ffull or Fmult are comparable only when the partial recruitment patterns (or selectivity) are constant over time.
- All other things being equal, reduced average weights at age imply lower biological reference points for biomass.

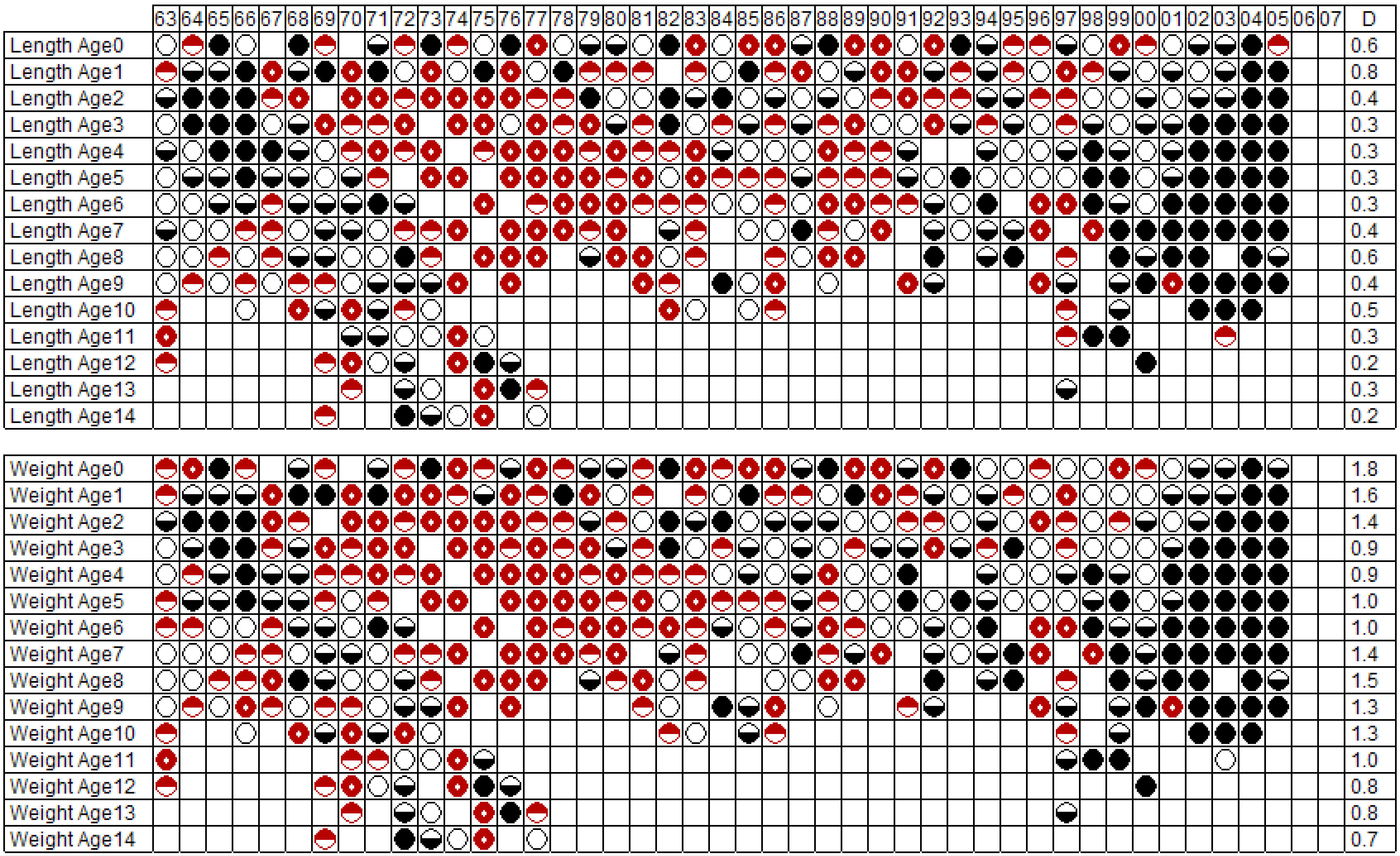
Mean Weights of ***juveniles***, grouped by area: Gulf of Maine, Georges Bank, Southern New England



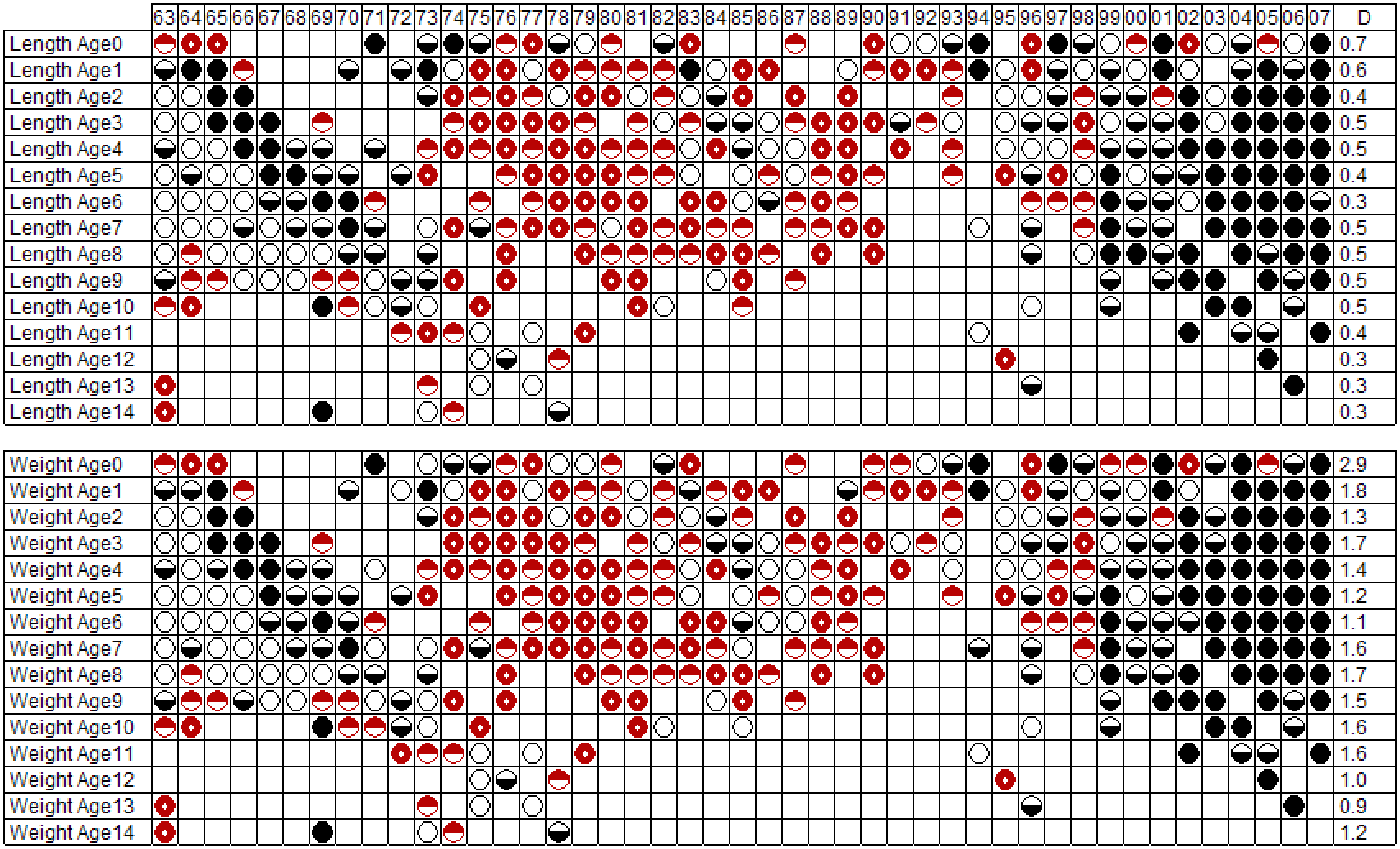
Mean Weights of ***adults***, grouped by area: Gulf of Maine, Georges Bank, Southern New England



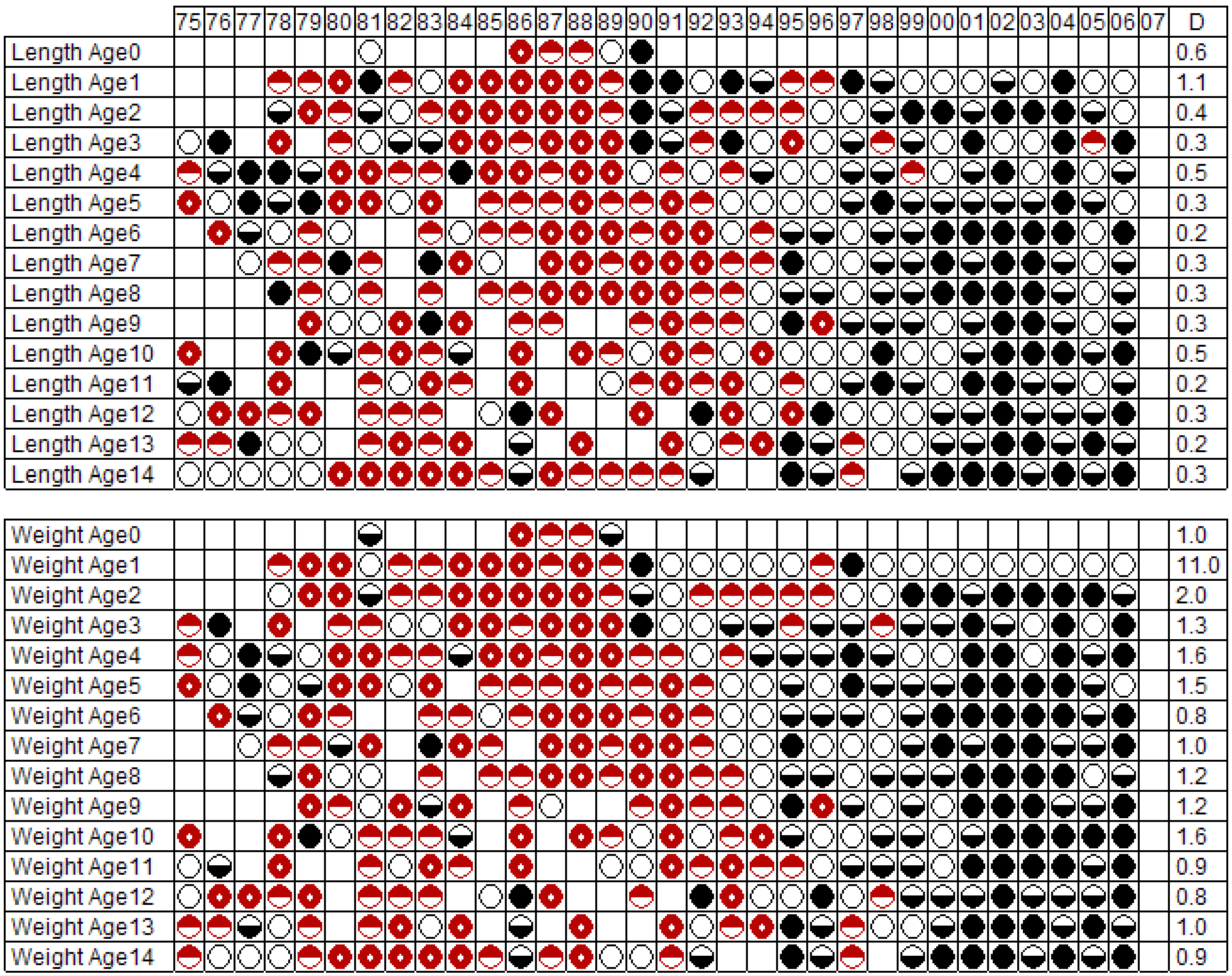
Georges Bank Haddock Autumn 1963-2005: Are reductions due to density, environment, or both?



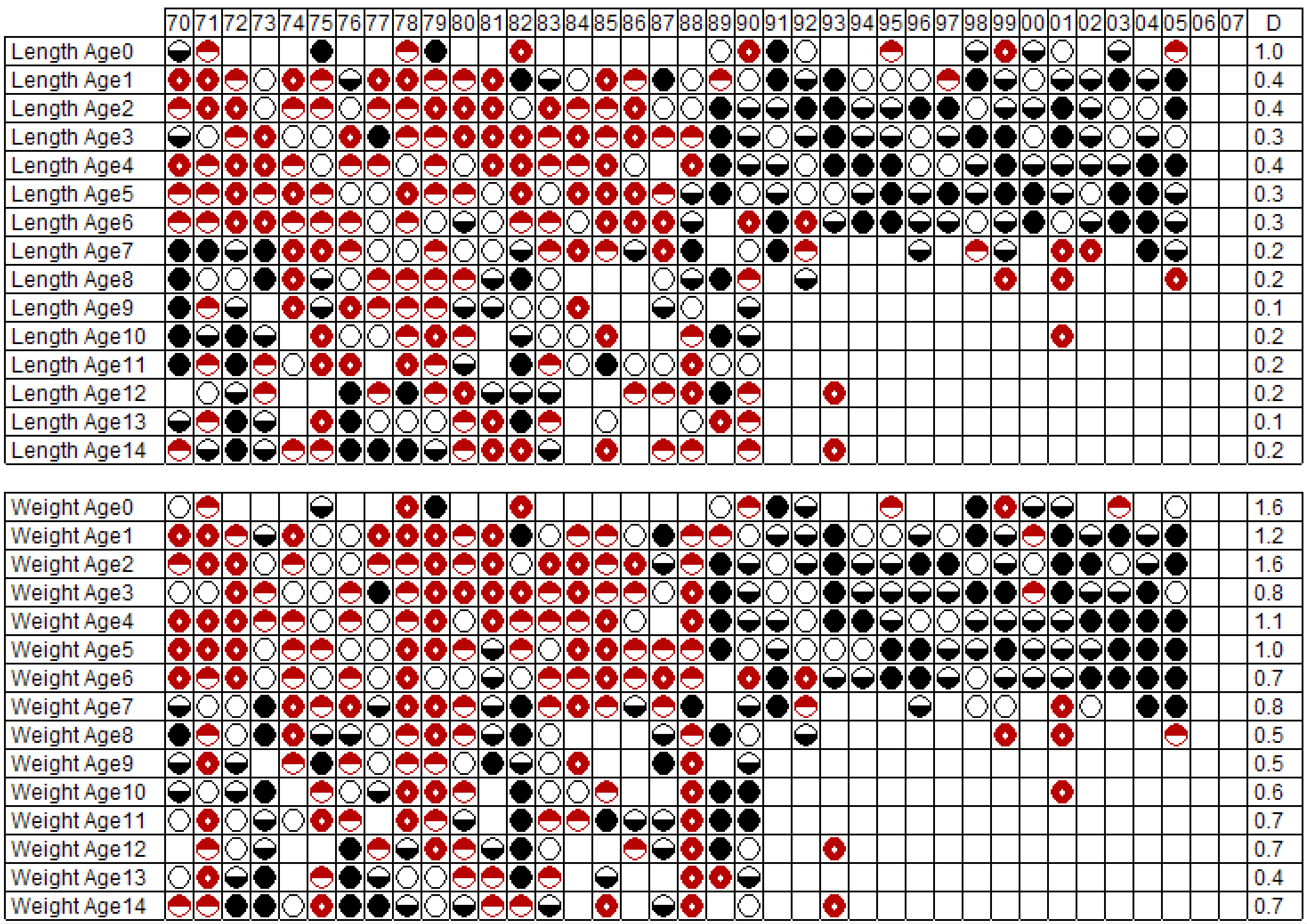
Gulf of Maine Haddock Autumn 1963-2007: Similar patterns with GB haddock suggest productivity changes.



Georges Bank/Gulf of Maine Redfish (Combined Sex) Autumn 1975-2007

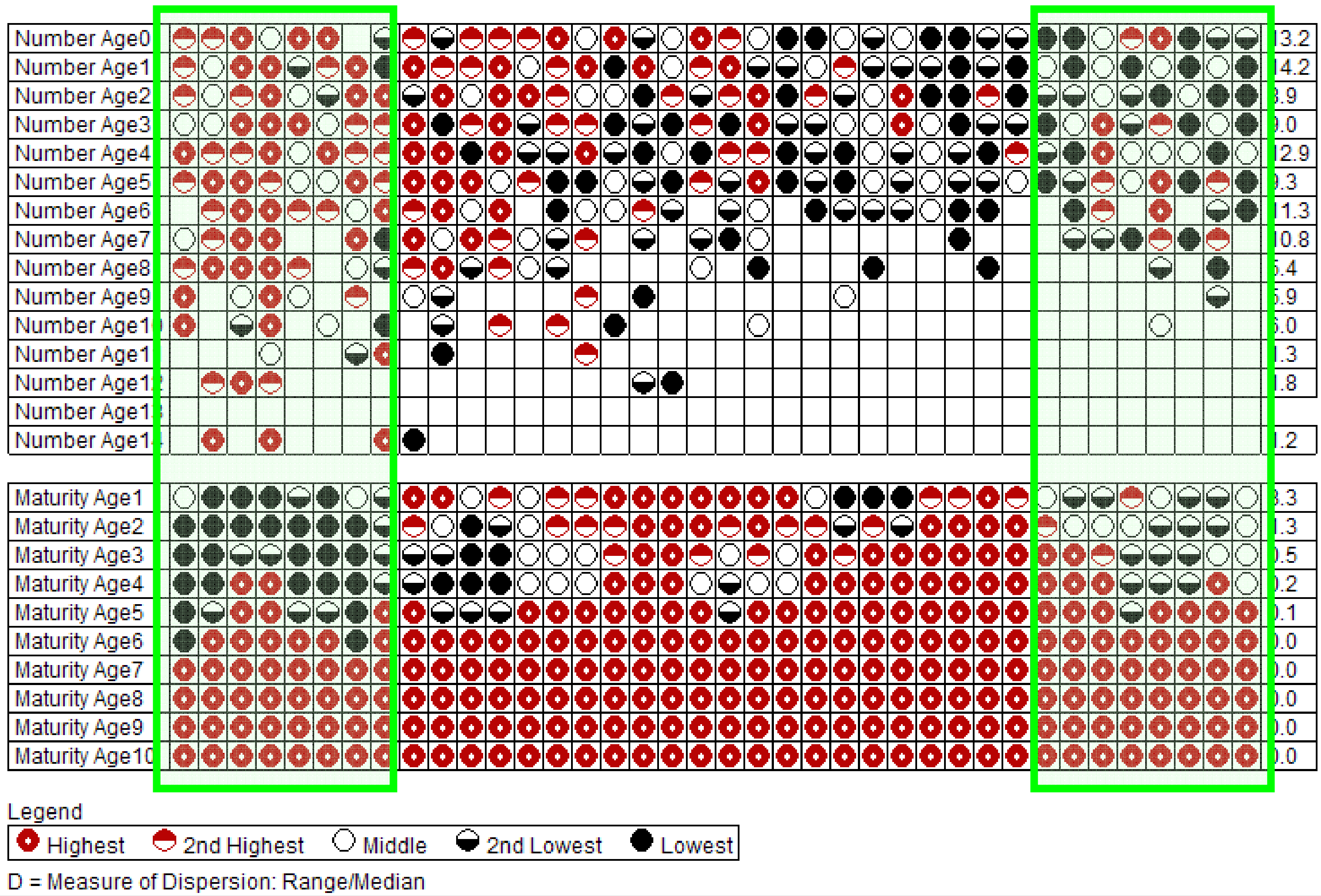


Pollock Autumn 1970-2005: Indirect evidence for use of early-mid 1990's as change point for retrospective adjustments?



Georges Bank Cod Autumn 1970-2007

Density effects on maturation not consistent. High density 1970-77 associated with delayed maturity. BUT Low densities 2000-07 had same pattern of delayed maturation.



Recruitment Effects

- Should the entire time series be included?
  - If not what subset is appropriate?
- Should outliers be excluded?
- How should trends be address?
- Retrospective patterns?

Example 1

- Pacific halibut (Clark et al. 1999) included underestimation of incoming yearclasses that required major changes in the model formulation. More importantly, proper treatment of temporal trends in growth and fishery selectivity "erased the previous appearance of strong density dependence in the stock recruitment relationship, and prompted a reduction in the target full-recruitment harvest rate from 30-35 to 20-25%" (Clark et al. 1999).

Example 2: Georges Bank haddock: Changes in growth rates (TRAC 2007) had important implications for in-season management measures on Georges Bank in 2007.

- High rates of discards were observed early in 2006-2007 by at-sea observers. The high rates were occurring because the 2003 yearclass, perhaps the largest on record, was growing more slowly than expected and a large fraction of this yearclass was below the minimum size limit.
- The Multispecies Groundfish Committee proposed a reduction in the minimum size limit from 19 inches (48.3 cm TL) to 17 inches (43.2 cm TL) for haddock caught on the US portion of Georges Bank.
- The proposed change in minimum size is expected to increase the fraction of the haddock available for landing in 2008 by a factor of 3 (ie. from 22% to 65%).
- Lowering the size limit would translate discards to landings, if, and only if, no changes in fishing practices or targeting of haddock occur. An increase in fishing effort could negate the conservation neutral effects of a lower size limit.

Summary

Multiple processes undoubtedly have some influence on the assessments of the 19 groundfish stocks. Critical issue will be estimating the magnitude of the joint effects of such changes. Key decisions include:

- Selection of the appropriate average weights at age for computation of biomass reference points
- Selection of average weight for the plus group in the projection.
- Selection of maturity schedule
- Partial recruitment (age specific selectivity)
- Number of years to include in stock recruitment function (whether parametric or nonparametric) and how or if to include estimates of recruitment strength from years prior to the assessment.
- Linkage to environmental factors?